Stroke, a Major and Increasing Risk Factor for Femoral Neck Fracture

Anna Ramnemark, MD, PhD; Mikael Nilsson, MD; Bengt Borssén, MD, PhD; Yngve Gustafson, MD, PhD

Background and Purpose—Patients with stroke have up to a 4-fold increased risk of hip fracture because of their high incidence of falls and loss of bone mass in the paretic side, ie, hemiosteoporosis. The purpose of this study was to investigate the prevalence of previous stroke among patients with femoral neck fracture.


Results—The prevalence of previous strokes ranged from 16.4% to 38.5% (P < 0.001); this finding is only partly explained by the increased incidence of stroke in the corresponding population, and there was no significant increase in the overall incidence of femoral neck fracture. Fractures occurred 5.4–6.4 years after stroke (median 2.9 years, range 0 to 33 years). In stroke patients with unilateral stroke and persisting paresis at the time of fracture, 62.5% had their fracture on the paretic side (P = 0.034). Survival was significantly reduced in patients with previous stroke (P < 0.001). In patients previously independently mobile, 69.2% with no previous stroke and 38.1% with previous stroke were still mobile at discharge from the orthopedic unit (P < 0.001).

Conclusions—Attention must be focused on stroke as a major and increasing risk factor for femoral neck fracture and also on the poor postfracture outcome and reduced survival of these patients. Prevention of poststroke fractures is necessary and is aimed at reducing the risk of poststroke fall and preventing the development of hemiosteoporosis. (Stroke. 2000;31:1572-1577.)

Key Words: outcome ■ osteoporosis ■ paresis ■ stroke

Hip fractures are an extensive threat to the health and survival of elderly people.1 The prevalence of hip fracture is increasing, principally because the population is living longer. Apart from age, osteoporosis, previous fracture, and falls are independent risk factors for hip fracture.2 Many other factors are associated with an increased risk of hip fracture, eg, poor health, reduced mobility, and cognitive impairment.3 These factors increase the risk of both osteoporosis and falls. Hip fractures are subdivided into femoral neck fractures and trochanteric fractures, and because the risk factors are somewhat different for these types, it is generally recommended that studies distinguish between these 2 fractures.4

Stroke is a major cause of mortality and morbidity in elderly people. Information on the prevalence of stroke is difficult to obtain. However, it is expected to increase, because the incidence of stroke increases extensively with age and because survival after stroke is prolonged.5,6 Some of the risk factors for stroke, such as age and smoking, and for complications after stroke, such as paresis and immobility, are also well-known risk factors for osteoporosis.7 Other symptoms after stroke, such as reduced balance and perceptual disturbances, increase the risk of falls, which are common in stroke patients.8 Accordingly, stroke patients would be expected to be at risk for both osteoporosis and falls and, consequently, for fractures.

Stroke patients have up to a 4-fold increased risk of hip fracture, and poststroke hip fracture occurs late after stroke (median is 30 months after stroke onset) and most often affects the paretic side.9 The increased incidence of fractures after stroke is partly due to loss of bone mass in the paretic extremities after stroke, ie, hemiosteoporosis, which begins early after stroke and continues to progress for the first years after stroke onset.10,11 The reported prevalence of previous stroke among patients with hip fracture ranges from 3% to 19%,12,13 but the prevalence has been studied neither recently nor over time.

In light of the increased risk of hip fracture in patients with previous stroke, the prevalence of stroke among patients sustaining a hip fracture could be expected to be increased compared with the prevalence of stroke among the general elderly population. Because the overall prevalence of stroke
is increasing, the prevalence of previous stroke among patients with hip fractures might increase over time.

The aim of the present study was to investigate the prevalence of previous stroke among patients with femoral neck fractures in 5 age cohorts during the 1980s and 1990s and to compare the short-term outcome and mortality in patients after femoral neck fracture with and without previous strokes.

Subjects and Methods
All 568 patients, aged ≥65 years, who underwent surgery for femoral neck fracture during 1980, 1983, 1987, 1993, and 1997 at the orthopedic clinic of Umeå University Hospital, Umeå, Sweden, were included in the present study. This hospital is the only emergency hospital that receives patients with femoral neck fracture in the primary catchment area (116,000 to 136,000 inhabitants from 1980 to 1997). Cases were included on the basis of orthopedic surgery records, and data were collected retrospectively from the patients’ orthopedic, anesthetic, geriatric, and, if necessary, other hospital records. The majority of the patients included during 1983 (71%) and 1987 (64%) had participated in earlier studies, in which they were examined for signs of stroke both before and after surgery, and their data were collected independently from the documentation in the orthopedic records. However, these patients’ data regarding suspected strokes were completed in the same way as for the remaining cases.

For 14 patients (2.3%), no hospital records were found, and it was only possible to obtain data concerning sex, age, survival, date of surgery, and side of fracture. These patients were excluded from the remaining analyses. Single data were occasionally missing, but each proportion was calculated for those patients whose data were available. An estimation of corresponding stroke incidence for patients aged ≥65 years was obtained from the official medical register, and 1 event was defined as 1 admittance for stroke to the department of internal medicine, neurology, or neurosurgery per person per year. The number of days from fracture until death or until December 31, 1998 (study end, the complete 1-year survival for the study population) was calculated from the official medical register. Mortality was calculated (1-year survival in all patients and 5-year survival in all but the 1997 cohort), and 5-year survival was estimated.

All fractures were confirmed by radiography, and all patients underwent surgery involving internal nail fixation, prosthetic replacement, or, in a few cases, sliding screw and nail plate. A previous stroke was defined according to the definitions of the World Health Organization as an “acute neurologic dysfunction of vascular origin with sudden or at least rapid occurrence of symptoms and signs corresponding to the involvement of focal areas in the brain,” with symptoms lasting ≥24 hours, thus excluding transient ischemic attack. The documentation in the orthopedic records was the primary source of the stroke diagnosis. However, in patients with suspected or verified previous strokes, stroke data were collected from records of internal and geriatric medicine. Because the hospital is the only emergency hospital that receives patients with stroke in the catchment area, the great majority of these patients had been admitted to the same hospital for acute care after their strokes.

For statistical analysis, the Mantel-Haenszel χ² test and Student t test were used for significance tests of the differences in proportions and mean values between groups. Incidence rates (I) were calculated according to the following formula: I = A/R, where A is the number of events during each 1-year period, and R is the total number of people at the end of each year; for mortality rates, the number of people at the beginning of each time period was used as the denominator. ANOVA was used for comparison of mean age at fracture between cohorts. The Kaplan-Meier product-limit method was used to estimate the risk of fracture as a function of time, and the log-rank test was used to find differences between groups. A value of $P<0.05$ was considered statistically significant. All calculations were made using the statistical package SPSS. The study was approved by the Ethics Committee of the Medical Faculty of Umeå University (98-279).

Results
The overall incidence of femoral neck fractures and stroke in the population aged ≥65 years from 1980 to 1997 is presented in Table 1. The total incidence of both femoral neck fractures and stroke increased, as expected, significantly with age ($P<0.001$), except for the stroke incidence in the 1980 and 1983 cohorts, for which the increase was insignificant. For femoral neck fractures, there was no significant increase in the age-specific incidence, but for stroke, all age-specific incidences increased significantly ($P<0.001$). The total incidence of femoral neck fractures was unchanged during follow-ups; however, for stroke, the total incidence for those aged ≥65 years increased significantly ($P<0.001$).

The prevalence of previous strokes among patients with femoral neck fracture ranged from 16.4% to 38.5% and increased significantly during the years (Figure 1, $P<0.001$). The total number of cases with a verified previous stroke was 152 (27.4%). Among patients with femoral neck fracture, 39.0% of the men and 22.3% of the women had had a previous stroke ($P<0.001$).

Clinical characteristics for all patients are presented in Table 2. The majority of patients were women. Age differ-

### TABLE 1. Incidence (Percentage) of Femoral Neck Fracture and Stroke in the Elderly Population of Umeå Primary Catchment Area, 1980–1997

<table>
<thead>
<tr>
<th>Follow-Up Year</th>
<th>Age Groups</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>65–74 y</td>
<td>75–84 y</td>
<td>≥85 y</td>
</tr>
<tr>
<td>1980</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population, N</td>
<td>9729</td>
<td>4809</td>
</tr>
<tr>
<td>Fracture, n (%)</td>
<td>27 (0.28)</td>
<td>39 (0.81)</td>
</tr>
<tr>
<td>Strokes, n (%)</td>
<td>100 (1.03)</td>
<td>86 (1.79)</td>
</tr>
<tr>
<td>1983</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population, N</td>
<td>9903</td>
<td>5261</td>
</tr>
<tr>
<td>Fracture, n (%)</td>
<td>33 (0.33)</td>
<td>56 (1.06)</td>
</tr>
<tr>
<td>Strokes, n (%)</td>
<td>107 (1.08)</td>
<td>72 (1.37)</td>
</tr>
<tr>
<td>1987</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population, N</td>
<td>10 312</td>
<td>5830</td>
</tr>
<tr>
<td>Fracture, n (%)</td>
<td>36 (0.35)</td>
<td>60 (1.03)</td>
</tr>
<tr>
<td>Strokes, n (%)</td>
<td>134 (1.30)</td>
<td>130 (2.23)</td>
</tr>
<tr>
<td>1993</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population, N</td>
<td>10 679</td>
<td>6391</td>
</tr>
<tr>
<td>Fracture, n (%)</td>
<td>24 (0.22)</td>
<td>60 (0.94)</td>
</tr>
<tr>
<td>Strokes, n (%)</td>
<td>184 (1.72)</td>
<td>205 (3.21)</td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population, N</td>
<td>10 396</td>
<td>6993</td>
</tr>
<tr>
<td>Fracture, n (%)</td>
<td>37 (0.36)</td>
<td>62 (0.89)</td>
</tr>
<tr>
<td>Strokes, n (%)</td>
<td>149 (1.43)</td>
<td>158 (2.26)</td>
</tr>
</tbody>
</table>

*One stroke event was defined as 1 stroke admittance per person per year.
†Age was missing for 1 patient.
\[\text{Age}\]
ence between the sexes was insignificant in all cohorts except for the 1987 cohort, for which the mean age for men was greater than the mean age for women \((P=0.031)\). Mean age at the time of fracture increased significantly between cohorts for women \((P=0.034)\) but not for men. Mortality rates were unchanged during all years (Table 2). Men had shorter expected survival than did women (Figure 2, \(P<0.001\)).

Characteristics of patients with and without previous stroke are presented in Table 3. In patients with a previous stroke, hip fractures occurred 5.4±6.4 (mean) years after they had had their stroke (median 2.9 years, range 0 to 33 years), and no patient was documented as having a stroke simultaneously with the fracture. It was not possible to obtain sufficient data for subdiagnoses of strokes. Seventeen cases lacked information about the side of the stroke lesion, and 8 cases lacked information about persisting paresis at the time of fracture. In stroke patients with unilateral stroke \((n=91)\), irrespective of persistent paresis, 60.4% had had their fracture on the side opposite the stroke lesion in the brain \((P=0.046)\), and of patients with persisting paresis at the time of fracture \((n=73)\), the fracture was on the paretic side in 62.5% \((P=0.034)\).

![Figure 1. Proportion of previous strokes among patients with femoral neck fracture, 1980 to 1997 \((\chi^2=18.57, P<0.001)\). *No significant increase in the overall femoral neck fracture incidence during follow-up.*](image1)

![Figure 2. Survival after femoral neck fracture in men and women by Kaplan-Meier analyses. Probability of survival 5 years after hip fracture is shown for men (lower line, \(n=180\)) and women (upper line, \(n=388\)). Vertical lines indicate 95% CIs. Mean survival times (95% CI) are as follows: men, 2.45 (2.15 to 2.76) years; women, 3.65 (3.46 to 3.84) years. \(P<0.001\) by log-rank test between groups.](image2)

**Table 2. Clinical Characteristics at Time of Fracture in Elderly Patients With Femoral Neck Fracture**

<table>
<thead>
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<tbody>
<tr>
<td>No. of cases</td>
<td>78</td>
<td>115</td>
<td>127</td>
<td>113</td>
<td>135</td>
<td>568*</td>
</tr>
<tr>
<td>Women, n (%)</td>
<td>51 (65.4)</td>
<td>89 (77.4)</td>
<td>91 (71.7)</td>
<td>66 (58.4)</td>
<td>91 (67.4)</td>
<td>388 (68.6)</td>
</tr>
<tr>
<td>Age (mean±SD), y</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Women</td>
<td>77.4±6.9</td>
<td>79.1±7.1</td>
<td>78.4±7.3</td>
<td>80.8±7.0</td>
<td>80.5±7.4</td>
<td>79.3±7.2</td>
</tr>
<tr>
<td>Men</td>
<td>77.3±8.0</td>
<td>77.7±7.9</td>
<td>81.4±7.0</td>
<td>78.9±6.3</td>
<td>79.8±7.2</td>
<td>79.2±7.2</td>
</tr>
<tr>
<td>Previous medical diagnoses, %</td>
<td></td>
<td></td>
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<tr>
<td>Stroke</td>
<td>16.4</td>
<td>18.6</td>
<td>25.8</td>
<td>32.1</td>
<td>38.5</td>
<td>27.4</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>6.8</td>
<td>16.8</td>
<td>8.9</td>
<td>18.3</td>
<td>15.6</td>
<td>13.7</td>
</tr>
<tr>
<td>Dementia†</td>
<td>26.0</td>
<td>17.7</td>
<td>27.4</td>
<td>27.5</td>
<td>31.9</td>
<td>26.4</td>
</tr>
<tr>
<td>Previous hip fracture‡</td>
<td>6.8</td>
<td>12.4</td>
<td>12.9</td>
<td>19.3</td>
<td>11.9</td>
<td>13.0</td>
</tr>
<tr>
<td>Admitted from home§, %</td>
<td>50.0</td>
<td>46.0</td>
<td>50.8</td>
<td>55.0</td>
<td>54.1</td>
<td>51.4</td>
</tr>
<tr>
<td>Mobile,</td>
<td></td>
<td>%</td>
<td>91.5</td>
<td>94.5</td>
<td>95.8</td>
<td>93.7</td>
</tr>
<tr>
<td>Mortality, %</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>1 mo</td>
<td>1.5</td>
<td>6.5</td>
<td>4.8</td>
<td>1.8</td>
<td>7.4</td>
<td>4.7</td>
</tr>
<tr>
<td>1 y</td>
<td>18.5</td>
<td>19.3</td>
<td>21.4</td>
<td>18.6</td>
<td>20.7</td>
<td>19.9</td>
</tr>
<tr>
<td>5 y</td>
<td>58.5</td>
<td>45.0</td>
<td>54.0</td>
<td>57.5</td>
<td>⋯</td>
<td>⋯</td>
</tr>
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</table>

*Fourteen patients with missing data were excluded from the analyses of prefracture diagnosis, residence, and mobility.
†Including dementia with different etiology (ie, Alzheimer’s disease and vascular dementia).
‡Both femoral neck and trochanteric fractures.
§Patients lived in their own homes, not apartment hotels for the elderly, but may have had home service.
||Patients may have used aid.
Two types of early postoperative complications, documented in the orthopedic records, were more common among patients with previous stroke than among those without: postoperative stroke (4.1% versus 0.8%, respectively; \( P=0.007 \)) and early postoperative death during the stay at the orthopedic clinic (7.5% versus 1.5%, respectively; \( P<0.001 \)). For the remaining postoperative complications, there were no differences between the groups with and without previous stroke. Mortality in stroke patients was significantly increased (Table 3). Survival was significantly reduced in patients with previous stroke (Figure 3, \( P<0.001 \)), and this difference remained significant after adjustment for sex (\( P=0.001 \)).

During all years, about half of the patients had lived at home (Table 2). Of the patients who lived in their own homes before the fracture (n = 284), 38.8% with previous stroke compared with 62.8% with no previous stroke were discharged directly back home from the orthopedic department (\( P=0.002 \)). In the same group, 55.1% of patients with previous stroke compared with 23.5% with no previous stroke were discharged to geriatric rehabilitation (\( P<0.001 \)). Regarding ambulation in patients previously independently mobile (n = 471, who may have used aid), 38.1% with previous stroke and 69.2% with no previous stroke were still independently mobile at discharge from the orthopedic clinic (\( P<0.001 \)).

### Discussion

The prevalence of previous stroke among patients with femoral neck fracture in the present study (16.4% to 38.5%) was considerably greater than that previously reported (4% to 19%).\(^\text{13,17-21}\) and the significant increase has, to our knowledge, not hitherto been reported.

The increasing prevalence of previous stroke among patients with femoral neck fracture could partly be explained by the increasing incidence of stroke in the population, because the age-specific incidence of femoral neck fractures was unchanged. It was not possible to obtain optimal data about the incidence, or prevalence, of stroke in the cohorts, but it is likely that the increased incidence of stroke shown in the present study could explain only a part of the more than doubled prevalence of previous stroke among patients with femoral neck fracture. A contributory explanation of the findings might be increased survival after stroke during the last years, with prolonged time to develop hemiosteoporosis and to suffer poststroke falls. Unfortunately, it was not possible to estimate survival after stroke in the corresponding population. An increase of hip fracture incidence has previously been reported,\(^\text{22}\) but during recent decades, studies\(^\text{23,24}\) have reported a leveling off of the increase, which was also found in the present study. The previously reported increased incidence might be in trochanteric fractures compared with femoral neck fractures, because trochanteric fractures affect older persons and are more due to osteoporosis.\(^\text{22}\) A decreased
incidence of fracture could explain an increased prevalence of previous stroke among patients with femoral neck fracture, provided that stroke patients had the same risk of fracture, but the overall incidence of femoral neck fracture was approximately the same during the follow-up. A further explanation for the significant increase of stroke prevalence among patients with femoral neck fracture over the years may be a decreased severity of stroke, reported in northern Sweden during the time of the present study. Decreased severity of stroke may result in increased mobility and thereby an increased risk of poststroke falls and fractures.

Elderly people living in institutions have an increased risk of hip fracture, which is largely due to comorbidity. Stroke has been reported as a risk factor for hip fracture among younger men in particular and as a risk factor for suffering a second hip fracture. Most previous studies have concluded that it is the increased risk of falls that explains the increased risk of hip fracture in stroke patients. However, it has been shown that stroke patients in addition have reduced bone mass in their paretic extremities, that this development contributes to paresis and immobilization, but the correlation between the degree of paresis and the rate of bone loss is not definite. In the present study, the side of stroke lesion could significantly predict the side of fracture, irrespective of persistent paresis. Finally, stroke and osteoporosis have common risk factors, and it has been reported that in patients with pronounced aortic and carotid calcification, the bone mass of the spine is significantly reduced. This might suggest that there can be a pathophysiological connection between osteoporosis and vascular diseases, such as stroke.

The prevalence of dementia among stroke patients was high (40.8%), but there was no significant trend in the prevalence of dementia among patients with femoral neck fracture during follow-up. Demented persons in general have a greater risk of hip fracture (Alzheimer’s disease has been shown to lead to an increased risk of falls), but it is also possible that these persons lose bone mass because of, for example, reduced body weight, which could contribute to their elevated risk of fracture.

The poorer functional outcome in stroke patients early after fracture was apparent even in the subgroup that was previously independent. This subgroup needed more geriatric rehabilitation, and consequently, a large proportion of patients in postfracture rehabilitation could be expected to have had a previous stroke. Despite these data, limited literature is available about the rehabilitation of stroke patients after hip fracture. The overall mortality after femoral neck fracture in the present study was somewhat lower than that found in previous studies (which includes both femoral neck and trochanteric fractures), despite age criteria (patients aged ≥65 years) and the high prevalence of previous strokes. This might be due to the fact that patients suffering femoral neck fracture generally have lower mortality compared with patients who suffer trochanteric hip fractures. The actual mortality due to hip fracture has previously been calculated but is difficult to predict because the affected persons are generally old and ill. The significantly increased postfracture mortality in men has previously been reported for male hip fracture patients in general and is most likely due to higher levels of comorbidity. In addition, lifetime risk of stroke is higher in men than in women.

The prevention of hip fractures is necessary from the perspective of the individual and society. The extra cost of a hip fracture has been estimated as $20 000 the first year after fracture. The future prevention of fractures would be most successful by focusing on individual risk patients and by including the prevention and treatment of osteoporosis and a reduction in the risk of falls. Because patients with previous stroke constitute such a large subgroup among patients with hip fracture, they must be considered to be of special interest in the prevention of falls and hemiosteoporosis and in the protection against injury at trauma.

Another intervention must aim at improving outcome after fractures in stroke patients. This must start early and is probably best performed in a combined orthopedic-geriatric rehabilitation unit, previously suggested for patients with hip fracture in general.

The primary catchment area of our hospital is clearly defined, and there is no other emergency hospital that receives patients with femoral neck fracture or stroke, making the results reliable and the loss of patient records low. The incidence of stroke might be underestimated because we counted only patients admitted to the hospital, because of the estimation of 1 stroke event defined as 1 admittance for stroke per person per year, and because of the retrospective study design. However, there were no time-dependent biases to explain the increased prevalence of previous stroke among patients with femoral neck fracture between cohorts, because the majority of the cases from the 1980s were examined prospectively for signs of strokes. The least reliable figures affect the incidence of stroke in the oldest cohorts in the early 1980s, because a larger proportion of these patients was probably not admitted for acute care. The prevalence of postoperative complications was low, but these data might have been incomplete because the only source of information was notes in the orthopedic records.

We conclude that patients with a previous stroke constitute a large and increasing group among patients suffering from femoral neck fracture. Even the subgroup of stroke patients previously mobile and living at home before the fracture requires more rehabilitation and has poorer postfracture mobility after femoral neck fracture. Because stroke patients are at high risk for fracture, and some of the underlying causes are known, prevention can be possible by aiming at reducing the risk of poststroke fall and preventing the development of hemiosteoporosis. If a successful prevention program could be worked out in stroke patients, there would be potential saving of lives, suffering, and resources.

Acknowledgments

This study was supported by grants from the National Society for Research on Ageing, the Borgerskapet in Umeå Research Foundation, the Joint Committee of the Northern Health Region, the Foundation of County Councils in Sweden, the 1987 Foundation for Stroke Research, Västerbotten County Council, and Gun and Bertil Stohnes’ Foundation.
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Stroke. 2000;31:1572-1577
doi: 10.1161/01.STR.31.7.1572

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